

New species of Coccidia (Apicomplexa: Eimeriidae) from rodents from the Ruwenzori Mountains, Uganda

Jan R. Šlapeta^{1*}, David Modrý^{1,2} & Břetislav Koudela^{1,2}

¹Department of Parasitology, University of Veterinary and Pharmaceutical Sciences, Palackého 1-3, 612 42 Brno, Czech Republic

²Institute of Parasitology, Academy of Sciences of the Czech Republic, Branišovská 31, 370 05 České Budějovice, Czech Republic

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Three new species of Coccidia (Apicomplexa: Eimeriidae) are described from rodents of the Ruwenzori Mountains, Uganda. Oocysts of *Eimeria livingstonei* n.sp., found in *Lophuromys flavopunctatus* Thomas, 1888, are spindle-shaped, $19.6 (17.0\text{--}22.0) \times 13.6 (12.5\text{--}15.0) \mu\text{m}$, with a bilayered, moderately rough oocyst wall. An oocyst residuum is present. Sporocysts are ellipsoidal, with a flat Stieda body. Oocysts of *Eimeria stanleyi* n.sp. found in *Otomys denti* Thomas, 1906, are cylindrical and brownish, $26.9 (26.0\text{--}28.0) \times 14.3 (12.0\text{--}15.0) \mu\text{m}$; a polar granule is present and oocyst residuum absent. The oocyst wall is thick, unilayered, with a roughened surface. Sporocysts are broadly ellipsoidal and contain sporozoites with distinct refractile bodies. The oocysts of *Eimeria spekei* n.sp. were found in *Otomys denti* Thomas, 1906, and are ellipsoidal to cylindrical and unpigmented, $18.9 (18.0\text{--}20.0) \times 10.8 (10.5\text{--}12.0) \mu\text{m}$, with a smooth and unilayered oocyst wall. Sporocysts are broadly ellipsoidal with sporozoites with distinct refractile bodies. *Eimeria livingstonei*, *E. stanleyi* and *E. spekei* represent the first coccidian species described from *Lophuromys flavopunctatus* and *Otomys denti*.

Key words: Protista, new species, *Eimeria*, coccidia, Rodentia, Uganda.

INTRODUCTION

Infections with eimerian coccidia (Apicomplexa: Eimeriidae) are widespread among rodents, but little has been published on the coccidia of small rodents from tropical Africa (Pellérdy 1974; Levine & Ivens 1965). The first attempt to determine coccidian protozoa from African rodents was that of Fantham (1926) in South Africa, but the descriptions require further assessment. Rodhain (1954) described *Eimeria vinckei* from *Thamnomys s. surdaster* from the former Belgian Congo, (now Democratic Republic of Congo) and 10 *Eimeria* spp. were described from six species of African rodents by Levine *et al.* (1959) from Liberia. *Eimeria chinchillae* De Vos & Van der Westhuizen, 1968, causes clinical coccidiosis in captive chinchillas, although it is primarily a parasite of wild rodents in South Africa and shows low host specificity (Rodhain 1954; De Vos & Van der Westhuizen 1968; De Vos & Dobson 1970).

Many rodents, including the two host species in the subfamily Murinae, examined in this study,

occur syntopically in the upper part of the Ugandan Ruwenzori Mountains (Delany 1975). *Otomys denti* Thomas, 1906, occurs in East Africa, from the Ruwenzori Mountains and Virunga volcanoes in Uganda to the Nyika Plateau in Malawi and Zambia, to mountains in Central Tanzania (Dieterlen 1968; Delany 1975); the form *kemp*i has been treated as a distinct species (e.g. Thomas 1918; Ellerman 1941). *Lophuromys flavopunctatus* Thomas, 1888, is distributed from northern Angola, throughout the Democratic Republic of Congo, Uganda, Kenya to Tanzania, Malawi, northern Zambia and Mozambique and in an isolated area in Ethiopia (Dieterlen 1976). This paper provides descriptions of three new species of *Eimeria* from these two species of rodents.

MATERIALS & METHODS

One adult *Otomys denti* (form *kemp*i) and two adult *Lophuromys flavopunctatus* were trapped with Sherman traps around Bujuku Hut (3900 m) and Kitandara Lake Hut (4050 m) in the Ruwenzori Mountains in Western Uganda during field studies in August 1996. Rodents were euthanased and

*Author for correspondence. E-mail: slapetaj@vfu.cz

preserved alcohol. Animals were identified and deposited in the Zoologisches Forschungsinstitut und Museum Alexander Koenig (Mammal Section), Bonn, Germany (ZFMK).

Faecal samples were placed in 2.5 % (w/v) potassium dichromate solution and processed at the University of Veterinary and Pharmaceutical Sciences in Brno. Samples were screened for coccidia using flotation in Sheather's sugar solution (specific gravity 1.30). Measurements were made of 30 oocysts using of a calibrated ocular micrometer. All measurements are given as the mean followed by the range in brackets. Sporulated oocysts of each species were photographed and examined using Nomarski interference contrast optics.

RESULTS

Of three rodents examined, two passed coccidian oocysts. *Otomys denti* is a host of two new coccidian species and *Lophuromys flavopunctatus* one new coccidian species. Morphological comparison with previously reported species revealed that the coccidians represented three undescribed species of *Eimeria*.

Eimeria livingstonei n.sp., Figs 1, 4a

Description of oocyst. Oocysts spindle-shaped (predominantly) to ellipsoidal. Oocyst wall colourless to greyish, moderately rough, composed of two layers c. 1.3 µm thick at sides and narrowing to 0.7 µm at both ends. Outer layer thicker c. <1 µm, with a roughened surface, inner layer c. 0.2–0.3 µm, smooth and colourless. Micropyle and polar granule absent. Fine granular or loose oocyst residuum seen in most oocysts. Oocysts 19.6 (17.0–22.0) × 13.6 (12.5–15.0) µm, with a shape index (SI, length-width ratio) of 1.4 (1.5–1.3). Sporulated oocysts contained four sporocysts, each containing two sporozoites. Sporocysts ellipsoidal with a flattened Stieda body c. 1 µm high. A granular compact sporocyst residuum c. 3.5–4.0 µm in diameter present near centre of sporocyst. Sporocysts 12.0 (10.0–15.0) × 5.5 (5.0–6.0) µm, with SI of 2.2 (2.5–1.9). Sporozoites elongate, each with a distinct refractile granule and with barely visible nucleus.

Type host. *Lophuromys flavopunctatus* Thomas, 1888 (Rodentia: Muridae).

Type locality. Bujuku Hut (3900 m), Ruwenzori Mts, Uganda.

Site of infection. Unknown. Oocysts recovered

from faeces.

Sporulation. Exogenous. Oocysts were passed unsporulated in faeces.

Prevalence. 1/2 *L. flavopunctatus* was infected.

Type specimens. Photosyntypes deposited in Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice (R90/98). Symbiotype deposited in Zoologisches Forschungsinstitut und Museum Alexander Koenig (ZFMK 97.603) (Mammal Section), Bonn, Germany.

Etymology. The specific epithet is derived from surname of the Scottish medical missionary David Livingstone, who explored the unknown interior of Africa.

Eimeria stanleyi n.sp., Figs 2, 4b

Description of oocyst. Oocysts predominantly cylindrical in shape. Oocyst wall yellowish to brown, moderately rough, approximately 2 µm thick, consisting of a single layer. A micropyle and oocyst residuum absent. Polar granule present, c. 2 × 1 µm. Oocysts 26.9 (26.0–28.0) × 14.3 (12.0–15.0) µm, with an SI of 1.9 (2.1–1.7). Sporulated oocysts contained four sporocysts, each containing two sporozoites. Sporocysts usually broadly ellipsoidal in shape, 10.6 (10.0–11.0) × 5.6 (4.5–6.5) µm, with SI of 1.9 (2.2–1.6). A Stieda body not observed. Sporocyst residuum consisting of a few granules, usually grouped together and measuring c. 3 µm in diameter. Sporozoites elongate, each with a distinct refractile granule c. 3 µm in diameter and with barely visible nucleus.

Type host. *Otomys denti* Thomas, 1906 (Rodentia: Muridae), form *kempii*.

Type locality. Bujuku Hut (3900 m), Ruwenzori Mts, Uganda.

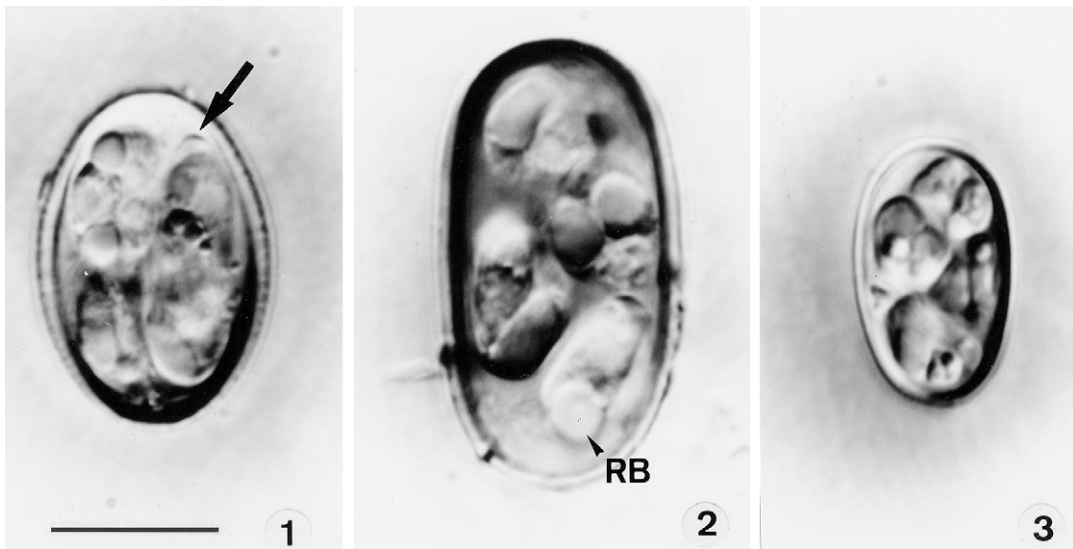
Site of infection. Unknown. Oocysts recovered from faeces.

Sporulation. Exogenous. Oocysts passed unsporulated in faeces.

Prevalence. 1/1 *O. denti* infected.

Type specimens. Photosyntypes deposited in Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice (R91/98). Symbiotype is deposited in Zoologisches Forschungsinstitut und Museum Alexander Koenig (ZFMK 97.601) (Mammal Section), Bonn, Germany.

Etymology. The specific epithet is derived from surname of journalist Henry Stanley, who helped David Livingstone explore Lake Tanganyika and who later explored the Congo River from its source to the Atlantic.



Figs. 1–3. Nomarski interference contrast photographs of sporulated oocysts of described species. All to same scale. 1, *Eimeria livingstonei*, note distinct Stieda body (arrow); 2, *E. stanleyi*, note sporozoite residual body (RB); 3, *E. spekei*. Scale bar = 10 μ m.

Eimeria spekei n.sp., Figs 3, 4c

Description of oocyst. Oocysts cylindrical to ellipsoidal in shape. Oocyst wall smooth, colourless, approximately 1 μ m thick, consisting of a single layer. A micropyle, polar granule and oocyst residuum not observed. Oocysts 18.9 (18.0–20.0) \times 10.8 (10.5–12.0) μ m, with SI of 1.7 (1.9–1.5). Sporulated oocysts contained four sporocysts, each containing two sporozoites. Sporocysts usually broadly ellipsoidal in shape, 8.7 (8.0–9.0) \times 5.1 (4.5–5.5) μ m, SI of 1.7 (1.8–1.6). A Stieda body not observed. Sporocyst residuum present, consisting of a few granules. Sporozoites elongate, each with a distinct refractile granule c. 2–3 μ m in diameter and with barely visible nucleus.

Type host. *Otomys denti* Thomas, 1906 (Rodentia: Muridae), form *kemp*i

Type locality. Bujuku Hut (3900 m), Ruwenzori Mts, Uganda.

Site of infection. Unknown. Oocysts recovered from faeces.

Sporulation. Exogenous. Oocysts were passed unsporulated in faeces.

Prevalence. 1/1 *O. denti* (form *kemp*i) infected.

Type specimens. Photosyntypes deposited in Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice (R93/98). Sym-biotype deposited in Zoologisches Forschungs-institut und Museum Alexander Koenig (ZFMK

97.601) (Mammal Section), Bonn, Germany.

Etymology. The specific epithet is derived from surname of John Hanning Speke, the first European to see Lake Victoria, during his search for the source of the Nile in 1856–1858.

REMARKS AND DISCUSSION

Eimeria livingstonei represents the first eimerian species to be described from the brush-furred mouse, *Lophuromys flavopunctatus*. Six eimerian species from *Lophuromys* s. *sikapusi* have been described from Liberia (Levine *et al.* 1959). Oocysts of *E. kruideneri* are similar in shape to those of *E. livingstonei* but are flattened at the ends and also differ in size. The other species differ in shape and morphology.

No species of *Eimeria* had been described to date from the groove-toothed rat, *Otomys denti*. The only species reported from the genus *Otomys* is *E. otomyis* from *O. irroratus* (DeVos & Dobson 1970). *E. stanleyi* differs from *E. otomyis* by its cylindrical shape, size and presence of moderately rough and approximately 2 μ m-thick oocyst wall. *E. spekei* differs from *E. otomyis* by having a smaller oocyst and sporocyst, and in the absence of a polar granule.

This is the first record of *Eimeria* from East African rodents. The African continent remains relatively unexplored from parasitological point of view despite our knowledge of medically important

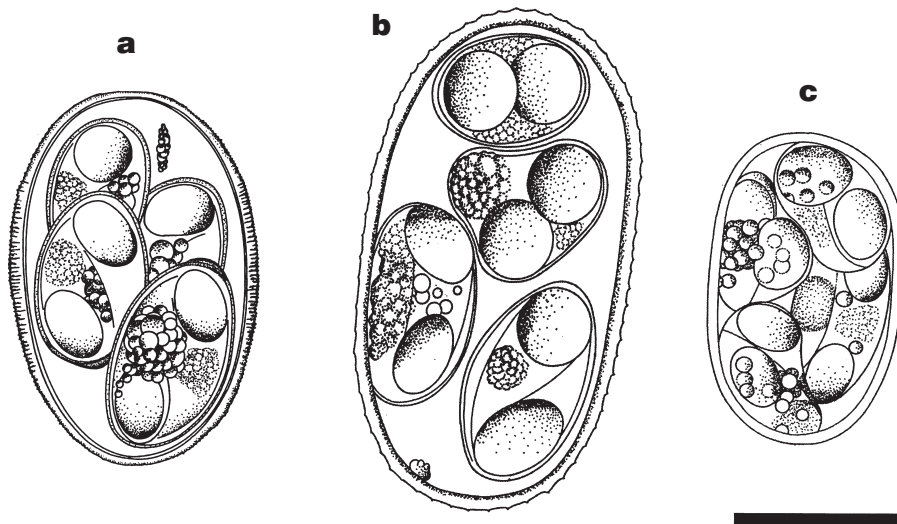


Fig. 4. Composite line-drawings of sporulated oocysts. **a**, *Eimeria livingstonei*; **b**, *E. stanleyi*; **c**, *E. spekei*. Scale bar = 10 μ m.

parasites. The thesis of Levine *et al.* (1959), that the percentage of African rodents whose coccidia have been described is extremely low, remains true to date.

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REFERENCES

- DE VOS, A.J. & VAN DER WESTHUIZEN, I.B. 1968. The occurrence of *Eimeria chinchillae* n. sp. (Eimeriidae) in *Chinchilla laniger* (Molina, 1782) in South Africa. *Journal of South African Veterinary Medical Association* **39**: 81–82.
- DE VOS, A.J. & DOBSON, L.D. 1970. *Eimeria chinchillae* De Vos & van der Westhuizen, 1968 and other *Eimeria* spp. from three South African rodent species. *Onderstepoort Journal of Veterinary Research* **37**: 185–190.
- DELANY, M.J. 1975. *The Rodents of Uganda*. Trustees of the British Museum (Natural History), London.
- DIETERLEN, F. 1968. Zur Kenntnis der Gattung *Otomys* (Otomyinae; Muridae; Rodentia). *Beitrage zur*

- Systematik, Ökologie und Biologie zentralafrikanischer Formen. *Zeitschrift für Säugetierkunde* **33**: 321–352.
- DIETERLEN, F. 1976. Die afrikanische Muridengattung *Lophuromys* Peters, 1874. *Vergleiche an Hand neuer Daten zur Morphologie, Ökologie und Biologie. Stuttgarter Beiträge zur Naturkunde (A)* **285**: 1–96.
- ELLERMAN, J.R. 1941. *The families and Genera of Living rodents. Vol. II. Family Muridae*. British Museum (Natural History), London.
- FANTHAM, H.B. 1926. Some parasitic protozoa found in South Africa. IX. *South African Journal of Science* **23**: 560–570.
- LEVINE, N.D., BRAY, R.S., IVENS, V. & GUNDERS, A.E. 1959. On the parasitic Protozoa of Liberia. V. Coccidia of Liberian rodents. *Journal of Protozoology* **6**: 215–222.
- LEVINE, N.D. & IVENS, V. 1965. *The Coccidian Parasites (Protozoa, Sporozoa) of Rodents*. University of Illinois Press, Urbana.
- PELLÉRDY, L.P. 1974. *Coccidia and Coccidiosis*. 2nd edn. Paul Parey, Berlin und Hamburg.
- RODHAIN, J. 1954. *Eimeria vinckei* n. sp., parasite de l'intestine de *Thamnomys surdaster surdaster*. *Annales de Parasitologie Humaine et Comparée* **29**: 327–329.
- THOMAS, O. 1918. A revised classification of the Otomyinae, with descriptions of new genera and species. *Annals and Magazine of Natural History* (9) **2**: 203–211.